MINMAX®

# MSU01 SERIES

**DC-DC CONVERTER 1W,** SMD Package

## FEATURES

- **Compact Industrial SMD Package**
- **Unregulated Output Voltage**
- **I/O Isolation 1500 VDC**
- **Efficiency up to 91%**
- **Short Circuit Protection (Hiccup Mode)**
- **Wide Operating Temperature Range**
- **Cleaning-washable Process Available (optional)**
- **Qualified for Lead-free Reflow Solder Process according to IPC/JEDEC J-STD-020D.1**


## PRODUCT OVERVIEW

The MINMAX brand new MSU01 series is a compact industrial SMD package DC-DC converter designed for space-constrained applications that require reliable performance. It features unregulated output voltages of 3.3, 5, 12, 15, 24, ±5, ±12, and ±15 VDC, with I/O isolation of 1500 VDC, delivering up to 91% efficiency. The MSU01 series features short-circuit protection (Hiccup Mode). With a wide operating temperature range, it is suitable for harsh industrial environments. Additionally, an optional cleaning-washable process is available, and the product is qualified for lead-free reflow solder processes in accordance with IPC/JEDEC J-STD-020D.1 standards.

The MSU01 series is ideal for various industrial applications such as sensor systems, industrial control equipment, automation systems, and IoT devices where space is limited and reliability is critical. Its compact form factor and robust design make it a perfect fit for demanding industrial applications that require high performance in challenging conditions.

### Model Selection Guide

| Model Number | Input Voltage (Range) | Output Voltage | Output Current (2) | Input Current | | Load Regulation | Max. capacitive Load | Efficiency (typ.) |
|---|---|---|---|---|---|---|---|---|
| | | | Max. | @Max. Load | @No Load | | | @Max. Load |
| | VDC | VDC | mA | mA(typ.) | mA(typ.) | % (max.) | µF | % |
| **MSU01-05S033** | 5 (4.5 ~ 5.5) | 3.3 | 300 | 233 | 12 | 7 | 2200 | 85 |
| **MSU01-05S05** | | 5 | 200 | 227 | | 7 | 1000 | 88 |
| **MSU01-05S12** | | 12 | 84 | 224 | | 4 | 180 | 90 |
| **MSU01-05S15** | | 15 | 67 | 223 | | 4 | 120 | 90 |
| **MSU01-05S24** | | 24 | 42 | 224 | | 4 | 47 | 90 |
| **MSU01-05D05** | | ±5 | ±100 | 230 | | 7 | 470# | 87 |
| **MSU01-05D12** | | ±12 | ±42 | 224 | | 4 | 100# | 90 |
| **MSU01-05D15** | | ±15 | ±33 | 218 | | 4 | 68# | 91 |
| **MSU01-12S033** | 12 (10.8 ~ 13.2) | 3.3 | 300 | 98 | 7 | 6 | 2200 | 84 |
| **MSU01-12S05** | | 5 | 200 | 96 | | 6 | 1000 | 87 |
| **MSU01-12S12** | | 12 | 84 | 95 | | 4 | 180 | 89 |
| **MSU01-12S15** | | 15 | 67 | 94 | | 4 | 120 | 89 |
| **MSU01-12S24** | | 24 | 42 | 96 | | 6 | 47 | 88 |
| **MSU01-12D05** | | ±5 | ±100 | 95 | | 6 | 470# | 88 |
| **MSU01-12D12** | | ±12 | ±42 | 94 | | 4 | 100# | 90 |
| **MSU01-12D15** | | ±15 | ±33 | 92 | | 4 | 68# | 90 |
| **MSU01-24S033** | 24 (21.6 ~ 26.4) | 3.3 | 300 | 51 | 5 | 6 | 2200 | 81 |
| **MSU01-24S05** | | 5 | 200 | 50 | | 6 | 1000 | 84 |
| **MSU01-24S12** | | 12 | 84 | 50 | | 4 | 180 | 85 |
| **MSU01-24S15** | | 15 | 67 | 49 | | 4 | 120 | 86 |
| **MSU01-24S24** | | 24 | 42 | 50 | | 4 | 47 | 85 |
| **MSU01-24D05** | | ±5 | ±100 | 51 | | 6 | 470# | 82 |
| **MSU01-24D12** | | ±12 | ±42 | 50 | | 4 | 100# | 85 |
| **MSU01-24D15** | | ±15 | ±33 | 49 | | 4 | 68# | 85 |

# For each output

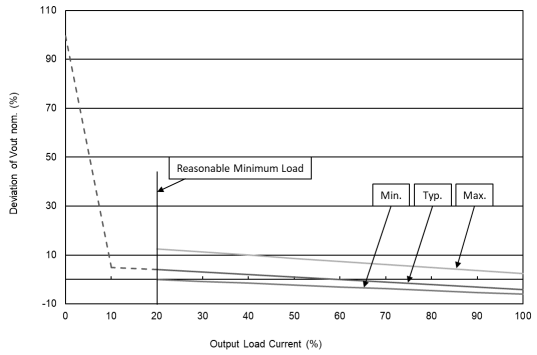
## Input Specifications

| Parameter | Model | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Input Voltage Range | 5V Input Models | 4.5 | 5 | 5.5 | VDC |
| | 12V Input Models | 10.8 | 12 | 13.2 | |
| | 24V Input Models | 21.6 | 24 | 26.4 | |
| Input Surge Voltage (1 sec. max.) | 5V Input Models | -0.7 | --- | 9 | |
| | 12V Input Models | -0.7 | --- | 18 | |
| | 24V Input Models | -0.7 | --- | 30 | |
| Internal Filter | All Models | Internal Capacitor | | | |

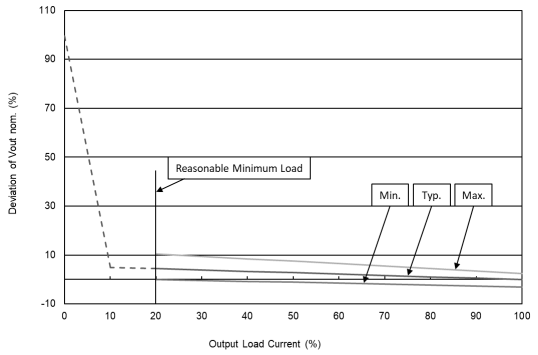
## Output Specifications

| Parameter | Conditions / Model | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Output Voltage Setting Accuracy | | --- | --- | ±3.0 | %Vnom. |
| Output Voltage Balance | Dual Output, Balanced Loads | --- | ±0.1 | ±1.0 | % |
| Line Regulation | For Vin Change of 1% | --- | ±1.2 | ±1.5 | % |
| Load Regulation | Io=20% to 100% | See Model Selection Guide (Operation at lower load will not damage the converter, but it may not meet all specifications) | | | |
| Ripple & Noise | 0-20 MHz Bandwidth | --- | --- | 100 | $mV_{P-P}$ |
| Temperature Coefficient | | --- | ±0.01 | ±0.02 | %/℃ |
| Short Circuit Protection | Continuous, Automatic Recovery (Hiccup Mode) | | | | |

## Output Voltage Tolerance




Output Voltage VS Output Load Current




Output Voltage VS Input Voltage Range

## General Specifications

| Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| I/O Isolation Voltage | 60 Seconds | 1500 | --- | --- | VDC |
| | 1 Second | 1800 | --- | --- | VDC |
| I/O Isolation Resistance | 500 VDC | 1000 | --- | --- | MΩ |
| I/O Isolation Capacitance | 100kHz, 1V | --- | 40 | 100 | pF |
| Switching Frequency | | --- | 240 | --- | kHz |
| MTBF (calculated) | MIL-HDBK-217F@25℃, Ground Benign | 5,013,824 | --- | --- | Hours |
| Moisture Sensitivity Level (MSL) | IPC/JEDEC J-STD-020D.1 | Level 2 | | | |

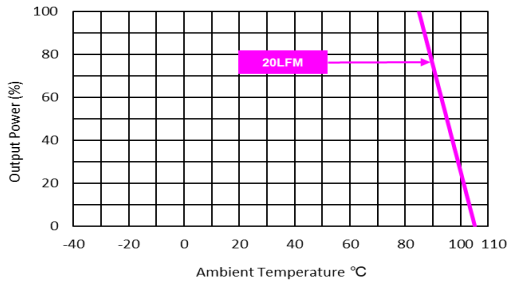
## EMC Specifications

| Parameter | Standards & Level | | | Performance |
|---|---|---|---|---|
| EMI(5) | Conduction | EN 55032 | With external components | Class A |
| | Radiation | | | |
| EMS(5) | EN 55035 | | | |
| | ESD | Direct discharge | Indirect discharge HCP & VCP | A |
| | | EN 61000-4-2 Air ± 8kV | Contact ± 6kV | |
| | Radiated immunity | EN 61000-4-3 10V/m | | A |
| | Fast transient | EN 61000-4-4 ±2kV | | A |
| | Surge | EN 61000-4-5 ±2kV | | A |
| | Conducted immunity | EN 61000-4-6 10Vrms | | A |
| | PFMF | EN61000-4-8 30A/m for Continuous; 1000A/m for 1 s | | A |

## Environmental Specifications

| Parameter | Min. | Max. | Unit |
|---|---|---|---|
| Operating Ambient Temperature Range (See Power Derating Curve) | -40 | +85 | ℃ |
| Case Temperature | --- | +105 | ℃ |
| Storage Temperature Range | -50 | +125 | ℃ |
| Humidity (non condensing) | --- | 95 | % rel. H |
| Lead-free Reflow Solder Process | IPC/JEDEC J-STD-020D.1 | | |

## Power Derating Curve

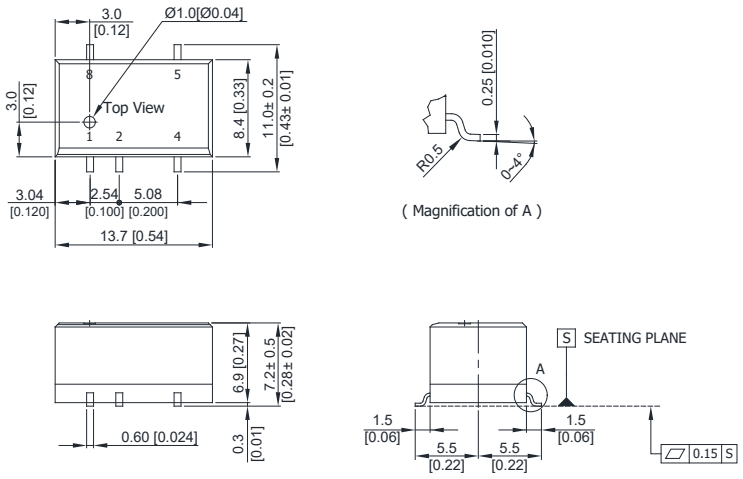



## Notes

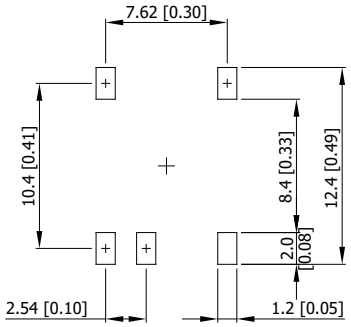
1 Specifications typical at Ta=+25℃, resistive load, nominal input voltage and rated output current unless otherwise noted.
2 These power converters require a minimum output loading to maintain specified regulation, operation under no-load conditions will not damage these modules; however they may not meet all specifications listed.
3 We recommend to protect the converter by a fast blow fuse in the input supply line.
4 Other input and output voltage may be available, please contact MINMAX.
5 The external components might be required to meet EMI/EMS standard for some of test items. Please contact MINMAX for the solution in detail.
6 Specifications are subject to change without notice.
7 The repeated high voltage isolation testing of the converter can degrade isolation capability, to a lesser or greater degree depending on materials, construction, environment and reflow solder process. Any material is susceptible to eventual chemical degradation when subject to very high applied voltages thus implying that the number of tests should be strictly limited. We therefore strongly advise against repeated high voltage isolation testing, but if it is absolutely required, that the voltage be reduced by 20% from specified test voltage. Furthermore, the high voltage isolation capability after reflow solder process should be evaluated as it is applied on system.

## Package Specifications

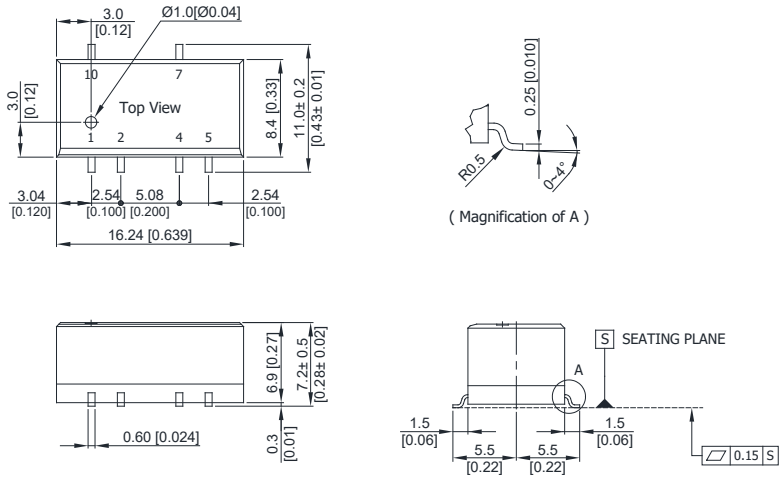
### Mechanical Dimensions (Single Output)



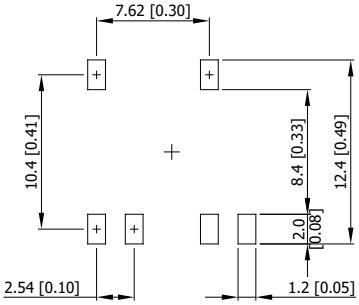

### Connecting Pin Patterns




### Mechanical Dimensions (Dual Output)




### Connecting Pin Patterns




- All dimensions in mm (inches)
- Tolerance: X.X±0.25 (X.XX±0.01)
  X.XX±0.13 (X.XXX±0.005)
- Pins ±0.05 (±0.002)

### Pin Connections

| Pin | Single Output | Dual Output |
|---|---|---|
| 1 | -Vin | -Vin |
| 2 | +Vin | +Vin |
| 3 | No Pin | No Pin |
| 4 | -Vout | Common |
| 5 | +Vout | -Vout |
| 6 | No Pin | No Pin |
| 7 | No Pin | +Vout |
| 8 | NA | No Pin |
| 9 | --- | No Pin |
| 10 | --- | NA |

NA : Not Available for Electrical Connection

## Physical Characteristics

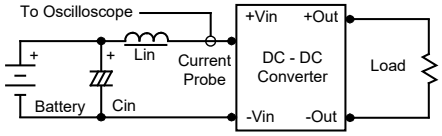
| | | |
|---|---|---|
| Case Size (Single Output) | : | 13.7x8.4x6.9mm (0.54x0.33x0.27 inches) |
| Case Size (Dual Output) | : | 16.24x8.4x6.9mm (0.64x0.33x0.27 inches) |
| Case Material | : | Plastic resin (flammability to UL 94V-0 rated) |
| Pin Material | : | Phosphor Bronze |
| Weight (Single Output) | : | 1.5g |
| Weight (Dual Output) | : | 1.61g |

| Order Code Table | |
|---|---|
| Standard | For cleaning-washable process |
| MSU01-05S033 | MSU01-05S033-W |
| MSU01-05S05 | MSU01-05S05-W |
| MSU01-05S12 | MSU01-05S12-W |
| MSU01-05S15 | MSU01-05S15-W |
| MSU01-05S24 | MSU01-05S24-W |
| MSU01-05D05 | MSU01-05D05-W |
| MSU01-05D12 | MSU01-05D12-W |
| MSU01-05D15 | MSU01-05D15-W |
| MSU01-12S033 | MSU01-12S033-W |
| MSU01-12S05 | MSU01-12S05-W |
| MSU01-12S12 | MSU01-12S12-W |
| MSU01-12S15 | MSU01-12S15-W |
| MSU01-12S24 | MSU01-12S24-W |
| MSU01-12D05 | MSU01-12D05-W |
| MSU01-12D12 | MSU01-12D12-W |
| MSU01-12D15 | MSU01-12D15-W |
| MSU01-24S033 | MSU01-24S033-W |
| MSU01-24S05 | MSU01-24S05-W |
| MSU01-24S12 | MSU01-24S12-W |
| MSU01-24S15 | MSU01-24S15-W |
| MSU01-24S24 | MSU01-24S24-W |
| MSU01-24D05 | MSU01-24D05-W |
| MSU01-24D12 | MSU01-24D12-W |
| MSU01-24D15 | MSU01-24D15-W |

## Test Setup

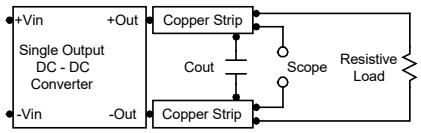
### Input Reflected-Ripple Current Test Setup

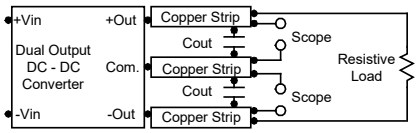
Input reflected-ripple current is measured with a inductor Lin (4.7μH) and Cin (220μF, ESR < 1.0Ω at 100 kHz) to simulate source impedance. Capacitor Cin, offsets possible battery impedance. Current ripple is measured at the input terminals of the module, measurement bandwidth is 0-500 kHz.




### Peak-to-Peak Output Noise Measurement Test

Use a Cout 0.33μF ceramic capacitor. Scope measurement should be made by using a BNC socket, measurement bandwidth is 0-20 MHz. Position the load between 50 mm and 75 mm from the DC-DC Converter.



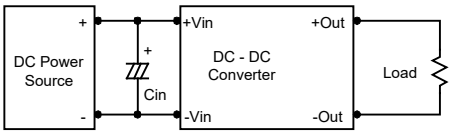

## Technical Notes

### Maximum Capacitive Load

The MSU01 series has limitation of maximum connected capacitance at the output. The power module may be operated in current limiting mode during start-up, affecting the ramp-up and the startup time. For optimum performance we recommend 33μF maximum capacitive load. The maximum capacitance can be found in the data sheet.

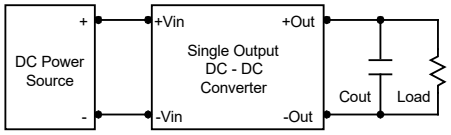
### Input Source Impedance

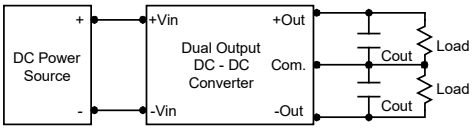
The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the power module. In applications where power is supplied over long lines and output loading is high, it may be necessary to use a capacitor at the input to ensure startup. Capacitor mounted close to the power module helps ensure stability of the unit, it is recommended to use a good quality low Equivalent Series Resistance (ESR < 1.0Ω at 100 kHz) capacitor of a 2.2μF for the 5V input devices, a 1.0μF for the 12V input devices and a 0.47μF for the 24V input devices.




### Output Ripple Reduction

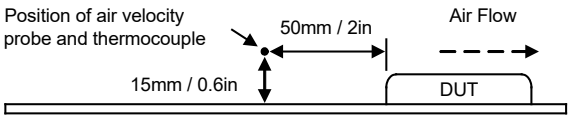
A good quality low ESR capacitor placed as close as practicable across the load will give the best ripple and noise performance. To reduce output ripple, it is recommended to use 3.3μF capacitors at the output.




### Thermal Considerations

Many conditions affect the thermal performance of the power module, such as orientation, airflow over the module and board spacing. To avoid exceeding the maximum temperature rating of the components inside the power module, the case temperature must be kept below 105℃. The derating curves are determined from measurements obtained in a test setup.

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